1. Purpose and Concept

The passage of rolling stock over the sudden transition between a radial curve and straight track or a reverse curve results in:

- lurching attributable to the sudden change of direction or
- an opposing push to adjoining cars.

In order to minimize these distracting occurrences it is recommended to lay easements both on the open road and in stations.

An easement is a curve with a constantly varying radius which reduces from infinity on the straight down to the constant radius of the curve. Easements are especially useful on tight curves while they may be omitted on curves > 60 G [1].

2. Description

Each half of the easement replaces a corresponding length of the straight and of the curve.

To connect the easement to the straight and the curve it is necessary to:

- either displace the straight by the value ***f*** (Fig 1);
- or diminish the radius of the curve by the value ***f*** (Fig 2)

Fig. 1

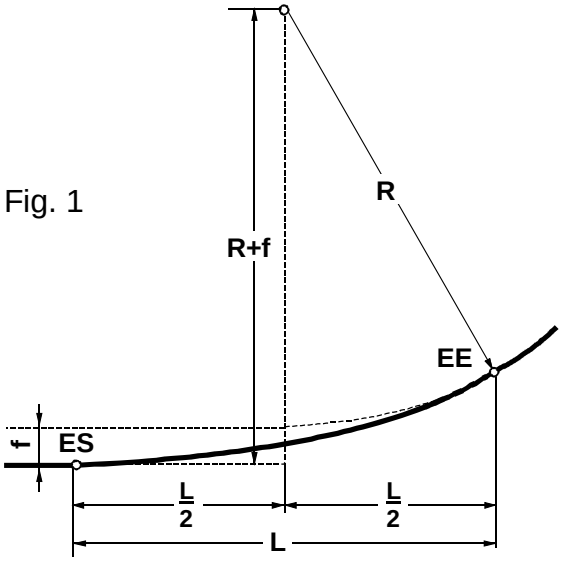
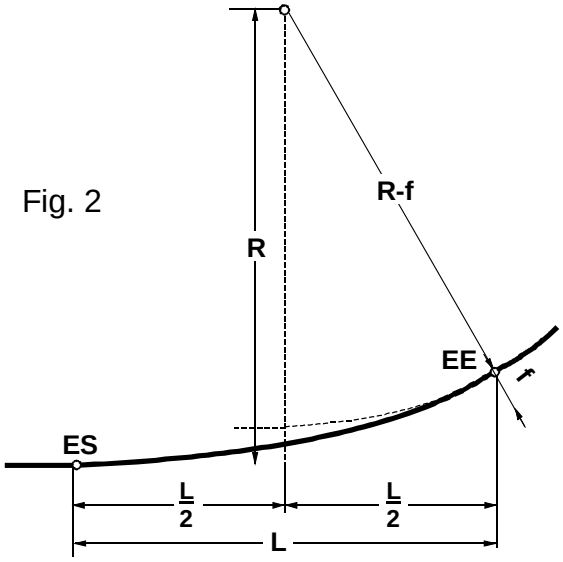


Fig. 2



Reverse curves with easements can eliminate a connecting straight track.

For curve super elevation, NEM 114 should be followed.

[1] G = track gauge

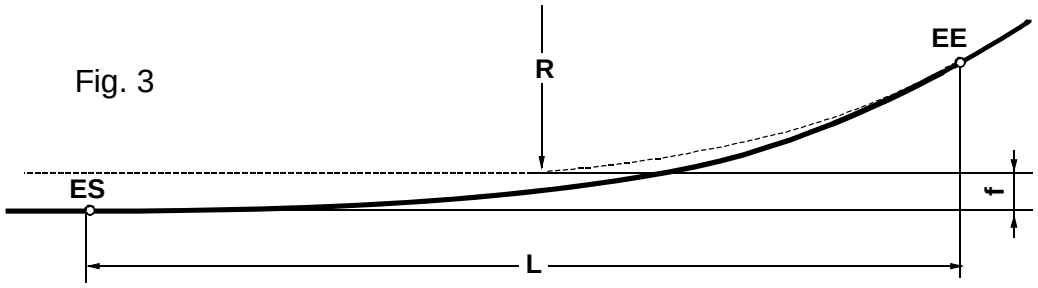
3. Dimensions

The values in Figure 3 for the easement key dimensions are as follows:

L = Length of the easement

f = Displacement of the straight and reduction of the radius.

Fig. 3



In order to obtain the proper combination of values ***L*** and ***f*** that complement a curve with a given radius ***R***, two methods are possible:

3.1 Use of Recommended Values

According to this method, for any gauge a constant value ***f*** can be obtained from Table 1:

Table 1

Gauge G	6,5	9	12	16,5	22,5	32	45	64
Value **f**	3	4	6	9	13	18	25	36

The easement may be computed using the formula:

$$L = \sqrt{f \bullet 24\,R}$$

or may be taken from Table 2 for the selected radii:

Table 2

G \ R	150	175	200	250	300	350	400	500	600	700	800	1000	1200	1400	1600	2000	2500	3000
6,5	100	110	120	135	145	160												
9		130	140	155	170	185	195	220										
12				190	210	225	240	270	295	320								
16,5						275	295	330	360	390	415	465						
22,5								395	430	465	500	560	610	660				
32										550	590	655	720	780	830	930	1040	1140
45												775	850	915	980	1095	1225	1340
64														1100	1175	1315	1470	1610

3.2 Pre-Selection of Easement Length

The Easement length **L** may be selected independently of the radius **R** as long as the following conditions are met:

- ***L*** must be smaller than ***R***, preferably < 0.8 R;
- ***L*** must be at least the length of the longest piece of equipment in use on the layout
- The value ***f*** varies as a function of the relationship ***L / R*** according to Table 3.

Table 3

$^{L}/_{R}$	<0,6	0,6 – 0,8	>0,8 (undesirable)
f	$\frac{L^2}{24\,R}$	$\frac{L^2}{23\,R}$	$\frac{L^2}{22\,R}$

4. Design and Construction [2]

After the values **L** and **f** are determined, the easement endpoints **ES** and **EE** may be determined by:

- extending the line of the intended straight track and drawing a line parallel to the straight track with the stand-off of $y_E = 4\ f$ which intersects the circle. This intersection is the endpoint **EE** of the easement;
- the startpoint **ES** is determined by tracing the length ***L*** from the perpendicular of the intersection at **EE** back along the extension of the straight track.

Either of two methods may be used to trace the easement.

4.1 Construction using intermediate points

The intermediate points $\mathbf{y_i}$ may be obtained as fractions of the end ordinate $\mathbf{y_E}$ according to Table 4.

Fig. 4

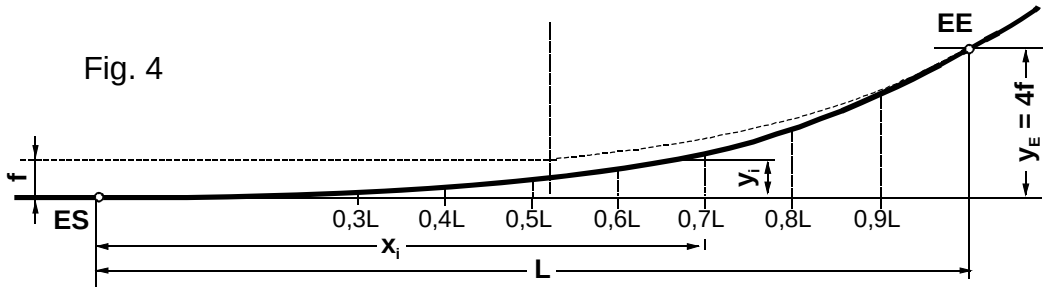


Table 4

x_i	0	0,3 L	0,4 L	0,5 L	0,6 L	0,7 L	0,8 L	0,9 L	1,0 L
y_i	0	0,03 y_E	0,06 y_E	0,125 y_E = 0,5 f	0,21 y_E	0,33 y_E	0,49 y_E	0,72 y_E	1,0 y_E = 4 f

Examples: Given: Gauge 16.5 and curve radius R = 600

Method 3.1		**Method 3.2**	
Value ***f*** per Table 1	**f** = 9	Selected easement length:	L = 0.7 R = 420
Easement length per Table 2	L = 360	Value ***f*** per Table 3	$L^2 / 23R \approx 13$
End points:	$y_E = 4\ f = 36$	End points:	$y_E = 4\ f = 52$
Intermediate points:	At $x_i = 0.7\ L$, $y_i = 0.33\ y_E$ (Table 4), thus:		
	$0.33 * 36 \approx 12$ etc.		$0.33 * 52 \approx 17$ etc.

[2] Since the model railroader is generally limited to a few selected curve radii, it is recommended to fabricate templates for the necessary easements according to the above described methods.

4.2 Use of an "elastic staff"

The path of the easement can be marked using an elastic staff according to Fig. 5. The preferred staff would be a perfectly elastic, square metal ruler with the approximate measurements of the rail profile. One end of the staff should be reinforced by soldering a plate to it, which can be used to affix the staff to the material beneath.

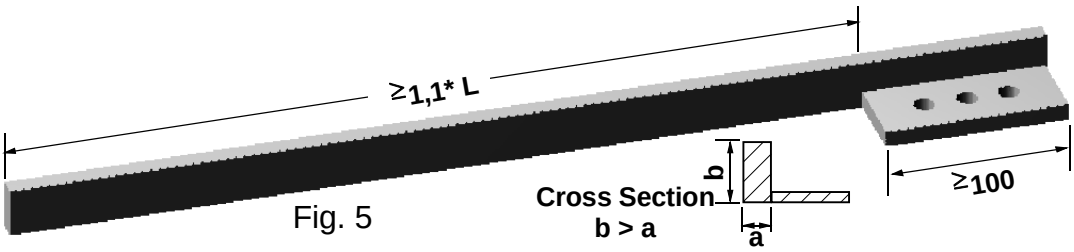


Fig. 5

At the point **EE**, the staff should be placed tangentially to the curve radius and the plate should be firmly affixed to the material underneath. By bending the staff until it reaches the point **ES** it will trace the line of the easement and serve as a template to mark it (Fig. 6).

If the radius center point is unknown or inaccessible, the tangent may be determined by finding the point K.

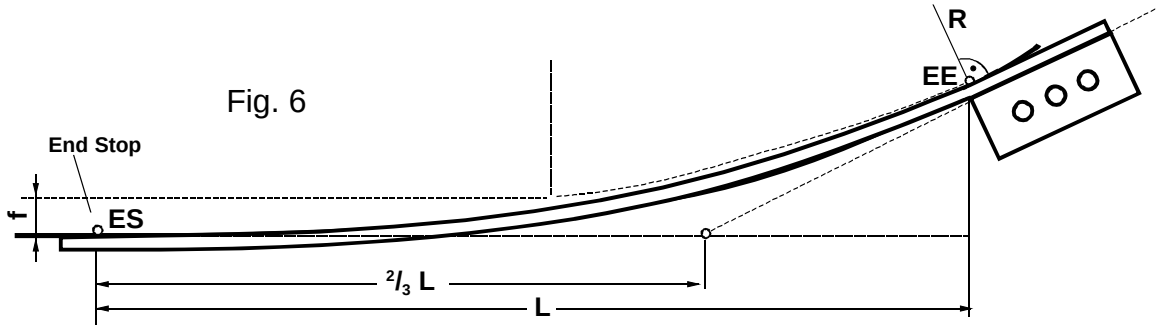


Fig. 6